Single Sideband Radios

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The requirement for greater mobility, operational flexibility, and dispersion on the nuclear battlefield will place an ever-increasing demand on communication systems. The increased distances between tactical units will make it necessary to rely more than ever on radio communication. The number of frequencies available for use by the field artillery is limited; therefore, the problem of frequency allocation is extremely complex. The range of future radios must be increased considerably over that of our present tactical amplitude modulated (AM) sets. The 40- to 100-mile range is of particular interest to the field artillery. AM radios are capable of providing reliable communication up to 40 miles and in the range beyond 100 miles, but the problem of communicating in the 40- to 100-mile range throughout a 24-hour period has not been satisfactorily solved to date. One solution to problems of frequency spectrum crowding and increased distances between tactical units is the single sideband radio (SSB). This article will explain some of the history of SSB and some of the advantages of its use over the present AM radios used by the artillery.

The possibility of single sideband transmission as a communication method was discovered in 1915. In 1918, the SSB concept was used in commercial wire carrier telephone equipment. The first transatlantic SSB signal was transmitted in 1923. Further experimentation with SSB transmission resulted in the first transoceanic SSB radiotelephone service between New York and London in 1927. Starting in 1936, SSB equipment was available in the high frequency spectrum for long distance radio communication and was put to use in transoceanic radiotelephone service. During World War II, the military found wide use for SSB in intercontinental communication. At the present time, improved SSB radio and radio telegraph sets are available for military, commercial, and amateur users. The single sideband system is recognized as the standard for extremely long range, point-to-point communication systems and is appearing in its new role of providing greater utilization of the frequency spectrum in high frequency, portable, vehicular, and avionic applications. The US Air Force, Navy, and Marine Corps, as well as some foreign armies, are presently using tactical SSB equipment.

Since the single sideband principle is a form of amplitude modulated radio, let's examine the transmission of our present AM sets and compare it to SSB transmission.

AMPLITUDE MODULATION

Modulation is the process of superimposing audio-frequency intelligence on a radio frequency (RF) carrier. This method of modulation is readily understood by an examination of an amplitude modulated wave. There are three components of an AM wave; the carrier component, the upper sideband, and the lower sideband (fig 1). The carrier component is steady in amplitude, conveys no intelligence, and is constant in frequency. The frequencies of the upper sideband are equal to the carrier

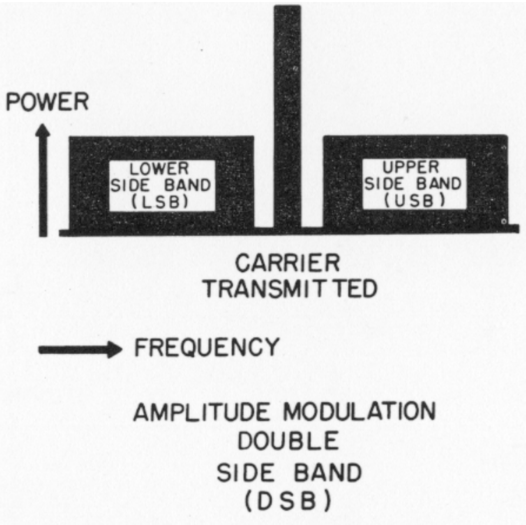

Figure 1. AM radio wave.

frequency plus the signal frequencies; the frequencies of the lower sideband are equal to the carrier frequency minus the signal frequencies. The sidebands carry all intelligence and are mirror images of each other. The term "signal" is used to represent the speech or basic intelligence being transmitted.

The intelligence bandwidth for voice communication is generally considered to be from 300 cycles per second (cps) to 3,000 cycles per second. A characteristic of amplitude modulation is that the radio signal requires a bandwidth twice that of the original signal. As an example, if the original signal contains frequencies from 300 cps to 3,000 cps, the total bandwidth requirement of an amplitude modulated wave would be 2 times 3,000 or 6,000 cps.

A major disadvantage of AM receiving equipment is that it cannot discriminate between natural electrical disturbances and the transmitted signal. Another disadvantage is that power is required to transmit the carrier even when no intelligence is being transmitted.

SINGLE SIDEBAND

Let us now investigate the single sideband radio and see how it can reduce some of the problems confronted by the artillery in its longer range communication systems. The SSB radio wave is similar to an AM wave except that only one sideband is transmitted (fig 2). The other sideband is filtered out and the radio frequency carrier is balanced out or suppressed. Since it is necessary to have a complete wave at the receiver in order to obtain the intelligence from the radio wave, the carrier

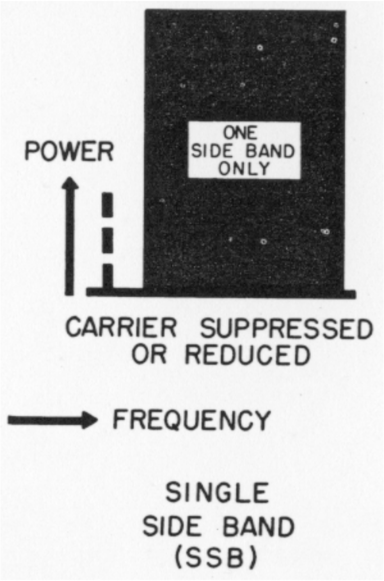

Figure 2. Single sideband wave.

must be reinserted at the receiver, and the other sideband must be reproduced. The carrier at the receiver must be of exactly the same frequency as the original carrier. This requires a very stable frequency generator and has been one of the main problems in adapting SSB for the mobile stations required by the artillery. However, in recent years, great strides have been made in overcoming this problem.

Single sideband radios offer economy both in frequency spectrum utilization and power consumption. This reduction of power required from the vehicle battery or other power supply is a very important aspect in the application of SSB for mobile applications. A single sideband system has considerably greater transmitted power output than that of a conventional AM system of equivalent power consumption. The reason for this increased power output is that no power is dissipated in transmitting the carrier and the unused sideband. All of the power is used to transmit the audio intelligence on only one sideband. An even greater power reduction results during the absence of transmission of intelligence. During These periods of no transmission, a SSB radio set consumes considerably less power than a conventional AM radio set, due to the absence of a continuously transmitted carrier. SSB is not as susceptible to electrical interference as an AM set because of the decreased bandwidth of the transmitted signal and because of a stronger received signal at a given distance from the transmitter. A comparison of bandwidth requirements for the various modulation methods used in radio communication today shows a significant advantage in the use of SSB. AM systems require approximately 7 kilocycles (kc), and single sideband systems require approximately 3.5 kc for voice transmissions. Therefore, a single sideband system can provide approximately twice as many channels as an equivalent AM system.

Now that we are acquainted with SSB and some of its advantages, let us see what is being done to provide operational sets in the high frequency tactical communication systems of the field army. The Army has programs for the development and production of two single sideband radio sets—the 50-mile tactical radio set AN/GRC-106 and the 100-mile tactical radio set AN/GRC-107—and two radio teletypewriter sets—the 50-mile tactical radio teletypewriter set AN/GRC-122 and the 100-mile tactical radio teletypewriter set AN/GRC-108. It is anticipated that these sets will provide reliable communication in the 40- to 100-mile range.

The radio set AN/GRC-106 is a vehicular-mounted (can be mounted in a 1/4-ton truck), single sideband radio set weighing approximately 70 pounds that will provide voice and continuous wave (CW) communication. Its frequency coverage is from 2.0 megacycles to 30.0 megacycles in 1 kc locked steps with vernier tuning between steps. This radio set operates from a 24-volt direct current, 25-ampere vehicular generating system. It will be used primarily in forward area tactical command, warning, meteorological, and administrative nets. It is presently planned to replace the radio set AN/GRC-19 with the AN/GRC-106.

The radio set AN/GRC-122 uses the same receiver-transmitter as the AN/GRC-106 and has all of the characteristics described for the AN/GRC-106 except that it is mounted in a shelter designed to be transported on a 3/4-ton truck. In addition to these characteristics, the AN/GRC-122 includes teletypewriter equipment which enables this radio set to provide voice, teletypewriter, and CW operation in single sideband radio nets in the 2 to 30 megacycle range. This radio set will replace some of the current radio teletypewriter equipment.

The radio set AN/GRC-107 is a high frequency radio set, weighing approximately 400 pounds, which can be mounted in the 3/4-ton truck shelter. It provides one voice or one CW channel in the frequency range of 2.0 megacycles to 30.0 megacycles in 1-kc locked steps with vernier tuning between steps. The transmission range of the AN/GRC-107 is 100 miles, and it operates from a 115/230-volt alternating current, single-phase, 60- or 400-cycle power source. The AN/GRC-107 will be used primarily as a tactical radio set in conjunction with other high frequency, single sideband radio sets in division, corps, and army communication systems.

The radio teletypewriter set AN/GRC-108 utilizes the radio set AN/GRC-107 as a component part and has all the characteristics of the radio set AN/GRC-107 described above. In addition to these characteristics the radio set AN/GRC-108 includes radioteletypewriter equipment which gives this radio set a full duplex voice, teletypewriter, and CW capability in the 2 to 30 megacycle range. This set will be used in high frequency, single sideband radio teletypewriter nets in the division, corps, and army.

Single sideband radios will make more economical use of the radio frequency spectrum. They will be smaller and lighter than the sets they replace and yet will offer greater capabilities (both in terms of frequency coverage and range). Modular construction will reduce maintenance requirements. They will provide greater reliability, will reduce the number of major components in the high frequency (HF) family of radios, will provide for component standardization throughout the HF family of radios, and will feature a higher degree of compatibility between the different HF radio sets. These radios will enhance mobility and communication flexibility on the battlefield. The radio sets AN/GRC-106 and -122 are expected to be available for issue in 1965, and the radio sets AN/GRC-107 and -108 are expected to be available for issue in 1967.

Although single sideband radios may not completely replace all present AM radio sets in the field army, it is certain that single sideband will play an ever increasing role in the communication systems of the artillery. The change from AM to SSB is necessitated by the requirement for greater range and reliability from tactical radios on a nuclear battlefield. The single sideband radio has been used with great success by the Marine Corps and the Navy shipboard communication systems. Tests substantiate the belief that the artillery will have the same success and that single sideband radios will be the backbone of future long range artillery communication systems.

AN/GRC-106 NEARS PRODUCTION

The Army has recently announced completion of development and testing of the AN/GRC-106. This two-way, transistorized set weighs 100 pounds and provides dependable 50-mile voice communications. Although half the size and weight of the set it replaces, the AN/GRC-106 provides ten times the effective signal power and twice the range through the use of advanced single sideband circuitry. This set operates on any one of 28,000 high frequency channels spaced one kilocycle apart. Tuning is simplified by the use of a digital tuning system in which a channel is selected by setting a series of knobs to prescribed numbers.